UNCLASSIFIED

AD NUMBER
AD020398
CLASSIFICATION CHANGES
TO confidential
FROM secret
AUTHORITY
ARDE List No. 1, Oct 1954-30 Jun 1956

THIS PAGE IS UNCLASSIFIED

The following ESPIONAGE NOTICE can be disregarded unless this document is plainly marked RESTRICTED, CONFIDENTIAL, or SECRET.

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

SECRET

COPY No. 45

MINISTRY OF SUPPLY

ARMAMENT RESEARCH ESTABLISHMENT

REPORT 19/53

WEAPONS RESEARCH DIVISION

Assessment of Blast Damage to Simple Structures

Part 1 Estimation of the Chamber Effect

J. W. Gibson and T. L. Wall
Safety in Mines Research Establishment, Buxton

Fort Halstead
Kent.

SECRET

August
1953

MINISTRY OF SUPPLY

Extra-mural research contract

with

SAFETY IN MINES RESEARCH ESTABLISHMENT, BUXTON

A.R.E. Report 19/53

Assessment of blast damage to simple structures

Part 1 - Estimation of the chamber effect

by

J.W. Gibson, B.Sc., and T.L. Wall, B.Eng.

CONTENTS

Approved

W.C.F. Shepherd .... for Director, S.M.R.E.

R. Blackman .... Senior Superintendent, A.R.E.

Buxton Report E 203 March, 1953

IMPORTANT

This DOCUMENT should be returned to the Chief Information Officer, Armament Research Establishment, Fort Halstead, Sevenoaks, Kent, if retention becomes no longer necessary.

INITIAL DISTRIBUTION

Internal

No. 1		CSAR
	2	SSMP
	3-4	SSMP - Att. Mr. J.W. Gibson, Mr. T.L. Wall
	5	- Mr. G.T. Laing (Shoeburyness)

United Kingdom

6-7	CS/ERDE
8	DWR(D)
9-18	Director, SMRE
19	AWRE - DD
20-21	- SPR
22	CEAD
23	DGFV
24	DRAE(GW)
25-26	MC of S
27-28	Royal School of Tank Technology
29-30	Sec. A.A. Lethality Committee (OB)
31	Sec.OB
32	- Att. Mr. Bishop
33	Prof. Pearson, University College, London

Overseas (through TPA3/TIB)

34-51	US - Joint Reading Panel
52	- R & D Board
53	- Applied Physics Laboratory, Johns Hopkins University (Att. Dr. C.F. Meyer)
54	- Ballistics Res. Lab. Aberdeen (Att. Dr. T.E. Sterne)
55	- Naval Ordnance Lab. Exp.Div. (Att. Dr. Paul Fye)
56	BJSM - P.O. Box 680, Benjamin Franklin Station, Washington D.C. (Att. ~~Mr. H.P. Hicks~~) Mr J.W. Gibson.
57	Canada - Dept.Nat.Def.
58-61	- Def.Res.Liaison
62	- Nat.Res.Council
63-64	TPA3/TIB - Retention

Stock

65-80

SUMMARY

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

INTRODUCTION

A great deal of work has been done on the damage to aircraft structures by internal and external blast; such trials entail the destruction of real or replica targets under conditions which simulate as closely as possible those conditions which are thought to be important in anti-aircraft attack. The purposes of these trials are many and varied and the experimental techniques may be illustrated by consideration of a recent investigation on the effect of altitude on internal blast damage to aircraft structures by small D.A. fused shell (Ref. 1). This comprised a study of the relative effectiveness of various H.E. fillings at altitudes and sea level and it was concluded that the damage effect at 50,000 ft. was reduced to about half that caused at sea level.

Damage is assessed in a somewhat arbitrary manner by inspection and comparison; skin damage caused by fragments or blast consists of bulges, holes or tears, all of which are measurable but not necessarily additive. A spar or rib may be dented, bent or fractured; a plate may be holed, cracked or deformed. The damage to the structure as a whole is given an assessment which is expressed as a percentage by comparison with damage to a similar structure under specified conditions. Long experience has resulted in a method of assessment which, in spite of its somewhat arbitrary nature, is reproducible and absolute in the sense that it provides a measure of those factors which result in a kill.

A complementary theoretical study of the reduction in blast from bare charges at high altitudes has been made (Ref. 2) and the conclusions reached are not inconsistent with the results of the field trials. A simple blast wave at a point in space may be described by three parameters, peak pressure P, duration of the positive pulse T and positive impulse I (defined to be $\int^{T} P dt$).

The shape of the positive pulse is often assumed to be constant and thus the pressure-time relationship may be expressed in terms of two parameters P and I. It is suggested from the theoretical treatment (Ref. 2) that, at 60,000 ft. altitude, the positive impulse I at a given distance from the charge is reduced to roughly half its value at sea level. With peak overpressure the reduction at altitudes depends on the magnitude of the pressure; when it is less than 5 p.s.i. there is a decrease of 50 per cent. Further information on the effect of altitude is available from U.S. Reports (Refs. 3 and 4).

The fundamental problem, then, is to correlate the pressure-time relationship which describes a blast wave (expressed in terms of measurable parameters) resulting from a charge or warhead with the damage to aircraft structures under realistic conditions. Sperrazza (Ref. 4) has assessed the dependence on peak pressure and impulse of damage to A-25 aircraft by external blast. Bare charges of 50/50 Pentolite varying from 8 to 5000 lb.

weight were detonated at various distances from the aircraft. For a given charge weight the distance between charge and target was varied until the target was damaged to specified extent. Measurements were made of the pressure pulses and values of P and I estimated. Thus, for each charge weight, estimates of P and I were obtained from the blast wave which resulted in standard damage, and by varying the charge, the relation between P and I for constant damage was derived. These relationships are empirical and not easily interpreted and it would seem that the correlation between pressure pulse and damage assessment might be simplified by a study of the damage by blast to simple structures.

Simple structures - If damage to a structure subjected to a pressure pulse of specified form can be analysed mathematically, then that structure may be regarded as being simple in the mathematical sense. A structure may be of simple shape (for example, a rectangular box made from thin sheet metal) and it may simulate some features of a more complex structure, yet the definition of the blast damage to it may be complex. The damage to such a target, however, may be described by a physical measurement, such as change in dimension or extent of deformation. Experiments made with relatively small targets may constitute a useful approach to understanding the mechanism of blast damage. The general study of the problem is summarised as follows:-

(i) A study of the pressure-time relationships resulting from detonations of bare charges of explosive, and methods of altering the shape of these pulses. The shape of the blast wave depends on distance from the charge, and suitable methods of measuring blast pressures must be developed. Piezo-electric gauges suitable for this application are in process of development and experimental data are closely linked with theoretical research.

(ii) A theoretical study of the effect of blast on mathematically simple structures, for example, the permanent deflection of a thin membrane or plate caused by an applied pressure pulse.

(iii) The correlation of measured damage to mechanically simple structures and measurements of the blast wave· this includes damage to plates and rods, and damage by internal and external blast to steel boxes which are freely suspended or rigidly attached to struts. The magnitude and shape of the pressure pulse may be varied by varying the distance between charge and target and by using different types of explosive. Most of the trials will be carried out with relatively small structures and a scaling investigation may be necessary. It is also planned to study the effects of altitude and temperature on blast damage by this technique, and a small pressure chamber will be required.

The final stage will be correlation of blast wave parameters with the damage criteria derived from theory, from simple trials and from field assessments.

The experimental approach outlined above may economise on full-scale trials in connection with the study of blast at altitudes. Some trials using representative aircraft structures were carried out at Pendine (Ref. 5). The experiments comprised static detonations of 20 mm. Hispano H.E./I shell within the structure and trials with the shell burst in flight by means of a burster plate fitted into the structure. All firings were made in the altitude firing chamber which is designed to give temperature and pressure conditions corresponding with any altitude from sea level to 50,000 feet. The chamber is cylindrical, of length 15 ft. and diameter 3 ft. 6 in. and with a removable end; the wing targets were approximately 4 ft. 6 in. long, 2 ft. 8 in. wide and 6 in. deep. The target was relatively large compared with the chamber and it was observed that there was a 'chamber effect' at sea level conditions; the confinement caused a considerable reduction (of the order of 40 per cent.) in the observed damage compared with the results of similar trials in the open air. Unfortunately it is not known to what extent the chamber effect varies with altitude. It was decided that experiments with simple model targets and varying degrees of confinement might throw light on this problem and provide information which would be of value in designing a full-size altitude chamber.

The present report, which describes the first stage of the general investigation, is concerned with the relationship between the amount of damage by internal blast to simple box structures and variation in size of the confining chamber.

EXPERIMENTAL

The precise damage to a simple box structure from blast resulting from a charge suspended internally is dependent on a number of factors, each of which is a source of variation; the dimensions of the box, thickness and hardness of the material, weight, shape and position of the charge must all be carefully controlled to give a reproducible damage criterion. It is convenient to express the damage to a specified type of target as a function of charge weight, all other factors being matched as far as possible. In choosing the exact type and shape of target, there are two main requirements to be satisfied; the damage should permit of precise measurement, and it should be reproducible. Variation within a batch of similar trials should be small so that small samples may be used and significant differences between batches clearly demonstrated. As is described below, the first design of target was a cylindrical rivetted steel can with open ends and this did not satisfy the requirements; the second type, a rectangular box with open ends was highly satisfactory.

Cylindrical rivetted cans - The cylindrical cans, of length 12 in. and diameter 6 in., were produced from tinned mild steel plate of thickness 0.031 in.; a rectangular sheet of metal was bent into a cylinder and the overlapping edges were secured by means of two rows of 24 rivets, spaced 0.5 in. apart. The ends were left open. The charge, consisting of a C.E. pellet of diameter 0.35 in. and of chosen length (length to diameter ratio varied between 1/2 and 2), was taped on to a wooden plug with inset detonator, the detonator being set along the axis of the cylinder. The charge was positioned by strings in the centre of the structure which was itself suspended in the open between two posts 6 ft. high and 10 ft. apart. This constituted an experiment in open air. To study chamber effects the target was positioned in the centre of a totally enclosed rectangular chamber of square cross-section constructed from steel plates. Damage from relatively small charges (4 gm. P.E.) consisted of plastic deformation, usually in a band running circumferentially around the middle of the can; a charge of 5 gm. resulted, in addition, in a tear along the rivetted joint. A charge of 7 gm. gave a long tear at the rivets together with other longitudinal tears in the can and general deformation of shape. Examples of damaged cans are shown in Fig. 1. In consequence, it was very difficult to obtain an exact estimate of overall damage; criteria adopted were (a) number of torn rivet holes and (b) the total length given by the sum of individual tears.

Rectangular cans - The first type of rectangular can was produced by bending and welding from a rectangular piece of mild steel 2 ft. x 1 ft. x 0.063 in., giving an open-ended box of length 1 ft. and square section 6 in. The dimensions of the nominally square section in a plane through the centre of the can were measured exactly and the charge positioned as before. After detonation the can was deformed but not torn, that is, the size of charge was such as to deform the square section into four circular arcs, and the two dimensions in the central plane were again accurately measured. Damage was defined as percentage increase in mean of two measurements and varied according to charge weight from zero to over 25. Between 0 and 25, this damage criterion was found to be very accurate and reproducible, and varied smoothly with variation of charge weight. Some deformed cans are shown in Fig. 2; if the charge was too large, the damage was less precisely defined and less dependent on the exact weight of charge detonated (Fig. 2C). Most of the trials were made with pressed C.E. pellets and as the charge weight was varied it was not always possible to maintain a fixed shape of charge (i.e. length to diameter ratio). Attempts were made to use an approximately spherical charge by moulding a given weight of P.E. around the end of the detonator; this resulted in damage which was subject to more variation than that obtained from the pressed tetryl.

Throughout most of the investigation the target consisted of the open-ended rectangular can with dimensions in the ratio 2:1:1. The thickness of steel was varied between 0.031 and 0.062 in. and length between 6 in. and 18 in.

Variation of chamber size - Although the reasons for the chamber effect are not clearly understood, we may assume for a given target shape that there is a chamber size within which damage to the target does not differ significantly from damage in a similar trial in open air. The target was open-ended with dimensions in the ratio 2:1 (length to diameter or width of square section) and the confining chamber was also of square cross-section and variable length. The size of chamber could not be varied systematically since use was made of such steel boxes and plates as were available; four types of chamber were used,

(a) a rectangular box of 1 ft. square section, and length variable from 14 in. to 8 ft.,
(b) a 2 ft. cube,
(c) a rectangular chamber 7 ft. x 3.5 ft. x 3.5 ft.,
(d) a rectangular box of 2 ft. square section, and length up to 6 ft.

EXPERIMENTAL RESULTS

Summary of trials - The series of trials are shown in Table 1, and a summary of the results in Tables 2-6 (Appendix). The results are shown graphically in Figs. 3-8.

No attempt has been made, as yet, to express damage as an empirical function of the dimensions of the target owing to the variations of thickness and hardness within a batch of nominally similar steel plates, but care has been taken to match each trial under specified confinement with an equivalent trial in open air. It is assumed and verified in some cases that, if damage to a target under certain conditions of confinement is significantly different from the equivalent experiment in open air, then similar pairs of targets of the same dimensions but produced from different steel would give the same answer.

TABLE 1 - Series of trials

Chamber size, ft. / Target size, in.	1 x 1 x L	2 x 2 x 2	3.5 x 3.5 x 7	2 x 2 x L
		Series code:		
6 (diam.) x 12	A	C		
6 x 6 x 12	B	D		K
4 x 4 x 8		E	G	
3 x 3 x 6		F	H	
5 x 5 x 10			I	L
9 x 9 x 18			J	
5.5 x 5.5 x 11				M

An interesting result obtained in the early stages of the investigation was that damage under confinement could be greater or less than in open air, depending on the degree of confinement. In Fig. 3 the percentage deformation is plotted as a function of charge weight for rectangular targets 6 x 6 x 12 in. produced from 0.062 in. thick steel. In series B the cross section of the confining chamber was constant (1 ft. square) and its length varied. With a length of 14 in. (1.17 ft.) which is only 2 in. in excess of the length of the target the damage was considerably greater than in open air. When the chamber length was increased to 2 ft. the deformation was decreased as a result of confinement. It can be seen that as the length is increased (up to 8 ft.) the damage curve is closer to the open air condition but a much greater increase in length might be necessary to give data which do not differ significantly from conditions of no confinement. This is shown in Fig. 7 where an attempt has been made to fit a smooth curve to a limited number of observations.

By including the data from series D in Fig. 3 it is seen that the effect of confinement cannot be explained simply as a function of the volume of the chamber. The damage in a chamber 2 x 2 x 2 ft. is closer to open air damage than that resulting from confinement in a box 1 x 1 x 8 ft.

In a systematic approach to the problem, the technique of varying the length of a chamber of fixed cross-section would seem a profitable one and curves similar to those in Fig. 7 are obtained from the results of series K, L and M. Given a chamber of 2 ft. x 2 ft. cross-section we find that a target 4 x 4 x 8 in. suffers damage similar to that in open air when the length exceeds a value between 3 and 4 ft. On the other hand with a target 6 x 6 x 12 in., there is a chamber effect with lengths up to 6 ft. It is estimated that the critical length for a target 5.5 x 5.5 x 11 in. is just about 4 ft.

The results from series E and F are summarised in Fig. 4 and it appears that a chamber 2 x 2 x 2 ft. affects the damage to targets of sizes 4 x 4 x 8 in. and 3 x 3 x 6 in. With a large confining chamber of fixed dimensions 3.5 x 3.5 x 7 ft., however, it is only when the target is as large as 9 x 9 x 18 in. that the chamber effect is apparent.

<u>Comparisons between cylindrical and rectangular cans</u> - It has been mentioned that the cylindrical rivetted target 6 in. (diam.) x 12 in. was unsatisfactory because of the large variation within a group of similar trials. It is interesting to note, however, that the results are comparable with the data from the rectangular targets. The curves in Fig. 6 are similar to those in Fig. 3 and the chamber effects are ranked in the same order.

DISCUSSION

In addition to obtaining information that has general application in the assessment of blast damage to simple structures, it was desired to assist in solving a particular problem, namely, the effect of the confining chamber on the degree of damage to a general target structure. Trials have so far been carried out only on a particular type of simple target, an open-ended box, and further the dimensions were always in the ratio 2 x 1 x 1. It is not to be expected that any precise chamber dimensions above which we estimate that the chamber effect is negligible will apply directly to other simple forms of target structure. Furthermore, the statement that two damage criteria do not differ significantly from each other needs some qualification. With the rectangular cans we have found that damage is reproducible, that is, within-batch variation is small. Percentage deformation (usually over the order of 20 per cent.) is expressed to the first decimal place, and in general a difference of 0.2 per cent. may be regarded as significant. This means that, if the damage assessment in open air is 20, damage under confinement is regarded as similar if its value lies between 19.8 and 20.2, that is within 1 per cent. of the value 20.

Estimation of chamber effect - In estimating minimum chamber size that results in damage similar to that obtained in open air (allowing a 1 per cent. level of error) the results suggest that we should specify a minimum chamber length for any cross-section above a certain minimum. Bearing in mind however that we have considered only one type of simple target structure, it is advisable to specify chamber size in more general terms, and assume that the chamber dimensions should be in the same ratio as the target dimensions, namely 2 x 1 x 1. Thus if the target is $2\ell \times \ell \times \ell$, the results suggests minimum chamber dimensions $9\ell \times 4.5\ell \times 4.5\ell$. Thus in order to obtain damage within 1 per cent. of open-air damage the linear dimensions of the chamber should be 4-1/2 times larger than those of the target. If a difference up to 5 per cent. is acceptable, four times linear dimensions should be sufficient. If it be desired to have a cubical confining chamber then its linear dimension should be at least four times the maximum dimension of the target.

Further trials will be carried out with other types of simple target and attempts will be made to specify more fundamentally the effects of confinement.

CONCLUSIONS

For open-ended rectangular cans of dimensions 2 x 1 x 1 that are deformed by internal blast whilst suspended in a confining chamber of dimensions $2k \times k \times k$, the damage is within 1 per cent. of that resulting from a similar trial in open air if k exceeds 4.5, and is within 5 per cent. if k is greater than 4.

The minimum chamber dimensions may be defined more exactly, however, with respect to this particular type of target by letting the chamber have dimensions $2\lambda \times k \times k$ when k must exceed some value k_o, and for each value of $k > k_o$, there exists a critical value of λ (say λ_o) which depends on k, such that λ must exceed λ_o.

Comparisons have been made with other types of simple target structures (cylindrical, open-ended, rivetted cans) and further trials are to be made.

REFERENCES

1. "Effect of altitude on internal blast damage to aircraft structures by small calibre D.A. fused shell"; O.B. Proc. Q7204, 1952

2. H.H.M. Pike & J.H. Bird; "The reduction in blast from bare charges at high altitudes"; A.R.E. Report 3/50

3. J. Dewey and J. Sperrazza; "The effect of atmospheric pressure and temperature on air shock"; B.R.L. Report No. 721, 1950

4. J. Sperrazza; "Dependence of external blast damage to A-25 aircraft on peak pressure and impulse"; B.R.L. Report No. 575, 1951

5. "Effect of altitude on internal blast damage to aircraft targets by small D.A. fused shell"; O.B. Proc. Q6996, 1951

APPENDIX

TABLE 2 - Summary of trials, Series B

Target size 12 x 6 x 6 in., thickness of steel 0.062 in.

Size of chamber 1 x 1 x L ft.

Chamber length, ft. L	Charge		Percentage deformation	
	H.E.	Weight gm.	Open air	Confined
1.17	P.E.	4		15.9
"	"	5	15.6	
"	"	6	18.7	26.2
"	"	7	21.3	28.5
"	"	8	22.1	
2	"	6	18.7	13.2, 14.0
"	"	7	21.3	14.9, 16.2
"	"	8	22.1	15.4
8	"	6	18.7	15.4
"	"	7	21.3	17.6

TABLE 3 - Summary of trials, Series D, E, F

Size of chamber 2 x 2 x 2 ft.

Series	Target		Charge		Percentage deformation	
	Dimensions in.,	Thickness of steel, in.	H.E.	Weight gm.	Open air	Confined
D	6 x 6 x 12	.06	P.E.	7	21.3	19.2
	"	"	"	8	22.1	21.1
E	4 x 4 x 8	.028	P.E.	1.0	16.5	
	4 x 4 x 8	"	"	1.5	23.3	
	4 x 4 x 8	"	"	2.0	31.5	
	4 x 4 x 8	.028	P.E.	1.0	13.0	
	"	"	"	1.5	22.7	
	"	"	"	2.0	25.2	
	4 x 4 x 8	.028	P.E.	1.0	14.0	
	"	"	"	1.25	12.0	
	"	"	"	1.5	16.2	
	"	"	"	1.75	15.7	
	4 x 4 x 8	.028	C.E.	.75	14.5	
	"	"	"	1.08	18.9 19.1	17.3
	"	"	"	1.50	21.8	21.3
F	3 x 3 x 6	.028	C.E.	.5	13.8	11.5
	"	"	"	.7	19.4	18.0
	"	"	"	1.07	24.4 24.8	24.4

TABLE 4 - Summary of trials, Series G, H, I, J

Size of chamber 7 x 3.5 x 3.5 ft.

Series	Target		Charge		Percentage deformation	
	Dimensions in.	Thickness of steel, in.	H.E.	Weight gm.	Open air	Confined
G	4 x 4 x 8 " 4 x 4 x 8 "	.032 " .032 "	C.E. " C.E. "	1.08 1.5 1.08 1.5	19.5 23.9 18.9 19.1 21.81	19.8 24.3 17.7 21.2
H	3 x 3 x 6 "	.032 "	C.E. "	.37 .74	12.1 19.4 18.2	12.1 19.8
I	5 x 5 x 10 " "	.026 .032 "	C.E. " "	1.08 " 1.5	24.3 14.1 19.0	23.9 13.9 19.2
J	9 x 9 x 18	.065	C.E.	11.0	18.3 18.4	17.2 18.0

TABLE 5 - Summary of trials, Series K, L, M.

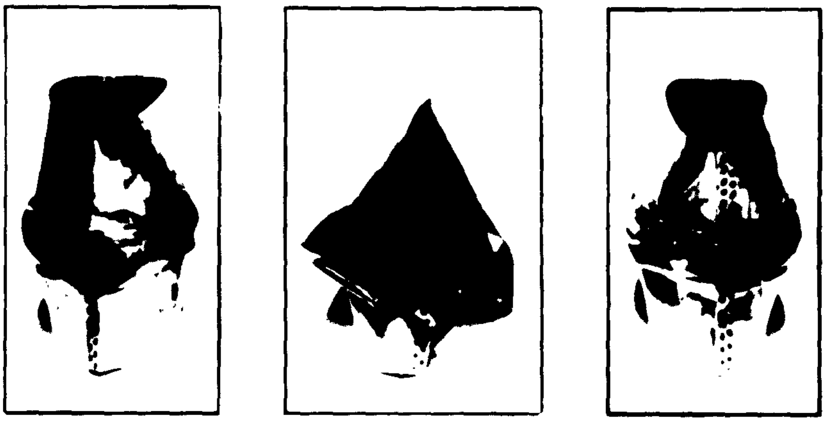
Size of chamber 2 x 2 x L ft.

Series	Chamber Length, L ft.	Target		Charge		Percentage deformation	
		Dimensions, in.	Thickness of steel, in.	H.E.	Weight gm.	Open air	Confined
K	1 4 5.75	6 x 6 x 12 " "	.063 " "	C.E. " "	7.18 7.17 7.16	16.7	30.3 13.8 14.9 15.4 15.7
L	1 2 3 4	5 x 5 x 10 " " "	.032 " " "	C.E. " " "	1.08 " " "	15.8 16.0	26.8 13.3 15.6 16.0 16.2
M	4 4 5	5.5 x 5.5 x 11 " "	.036 " "	C.E. " "	1.08 2.16 "	9.3 20.7 20.5	20.7 20.5 21.4

TABLE 6 - Summary of trials, Series A, C.

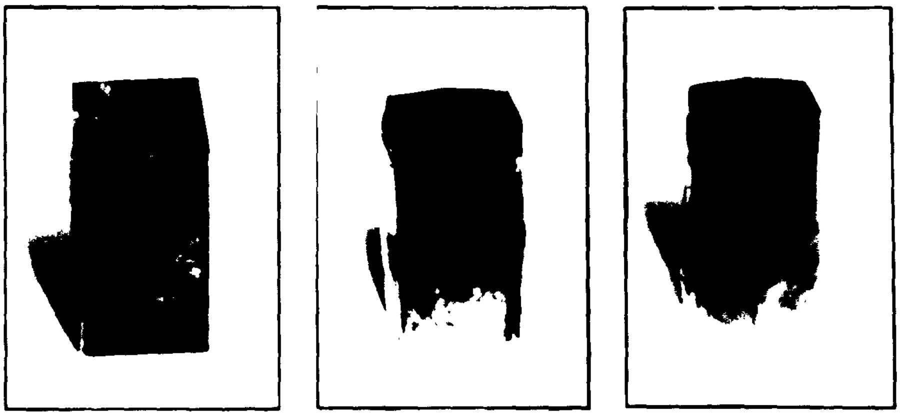
Target size 12 in. x 6 in. (diam.), thickness of steel (0.031) in.

Series	Chamber size, ft.	Charge		Damage	
		H.E.	Weight, gm.	Number of rivets torn	Total length of tear, in.
A	1 x 1 x 1.17	P.E.	4.5	0	0
	"	"	5.0	6	2.5
	"	"	5.5	15	8.3
	"	"	6.0	30 (23 + 7)	14.7
	"	"	6.0	21	14.9
	"	"	6.0	16	9.3
	"	"	7.0	14	15.9
	"	"	7.0	30 (16 + 14)	14.0
	1 x 1 x 2	P.E.	6.0	15	7.0
		"	6.0	15	7.0
	1 x 1 x 2	C.E.	3.2	15 (10 + 5)	12.2
			4.3	23 (12 + 11)	28.3
	1 x 1 x 8	P.E.	6.0	9	4.3
	"	"	7.0	22 (18 + 4)	10.8
C	2 x 2 x 2	P.E.	6.0	17 (9 + 8)	8.5
	"	"	7.0	20	10.0
	Open air	P.E.	4.5	0	0
	"	"	5.0	10	5.0
	"	"	5.3	8	3.8
	"	"	6.0	20 (11 + 9)	10.0
	"	"	6.0	15	7.9
	"	"	7.0	23	10.2
	"	"	7.0	21	13.4
	"	"	9.0	23	17.2
	"	C.E.	3.2	12	5.8
	"	"	4.3	20	17.0



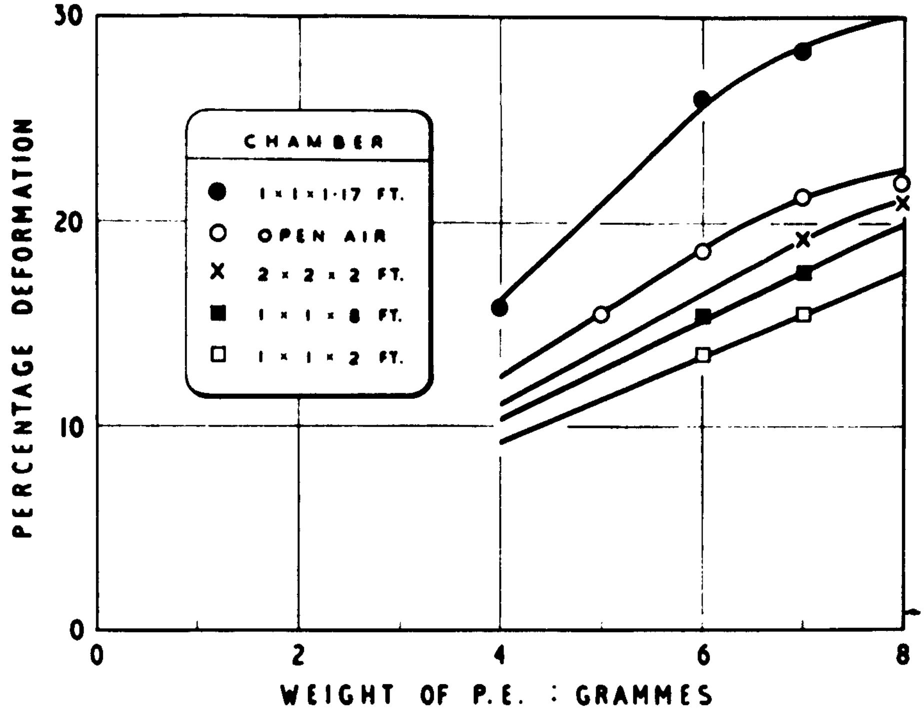
(a) (b) (c)

FIG. 1



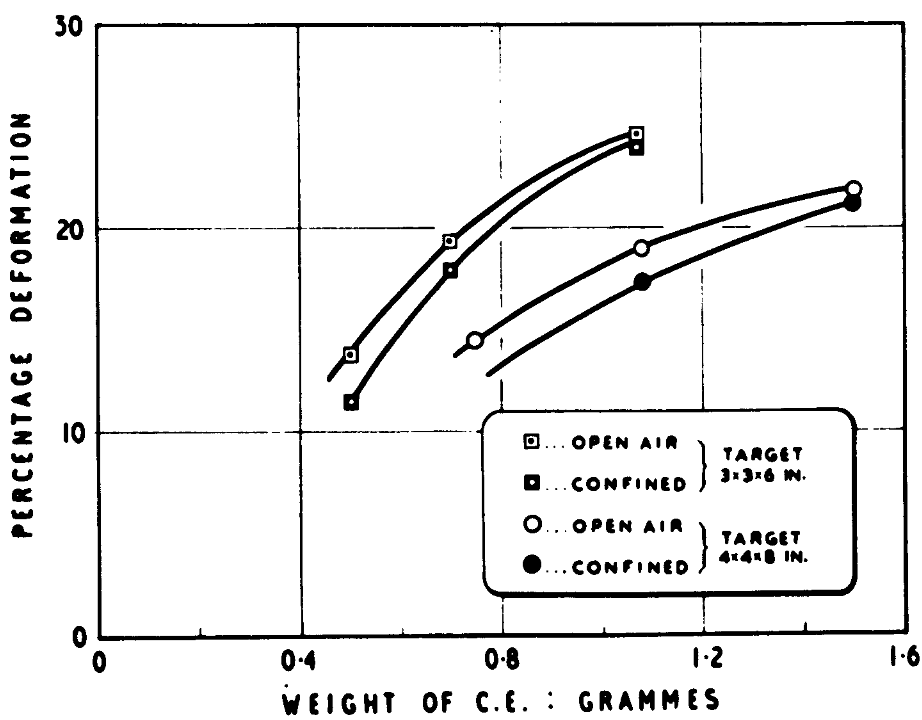
(a) (b) (c)

FIG. 2



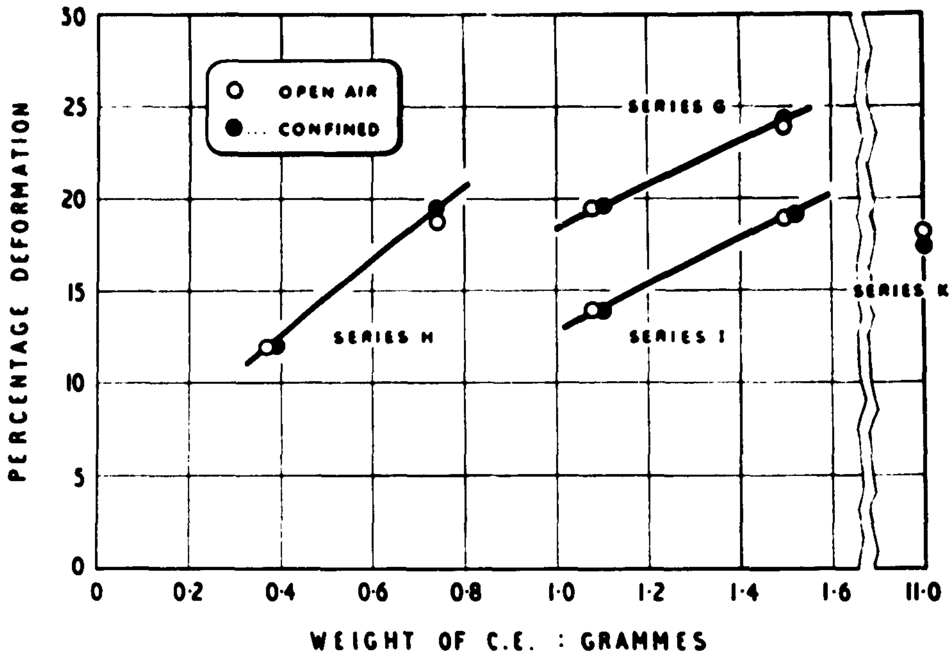
DATA FROM SERIES B AND D : TARGET 12 X 6 X 6 IN.

FIG. 3



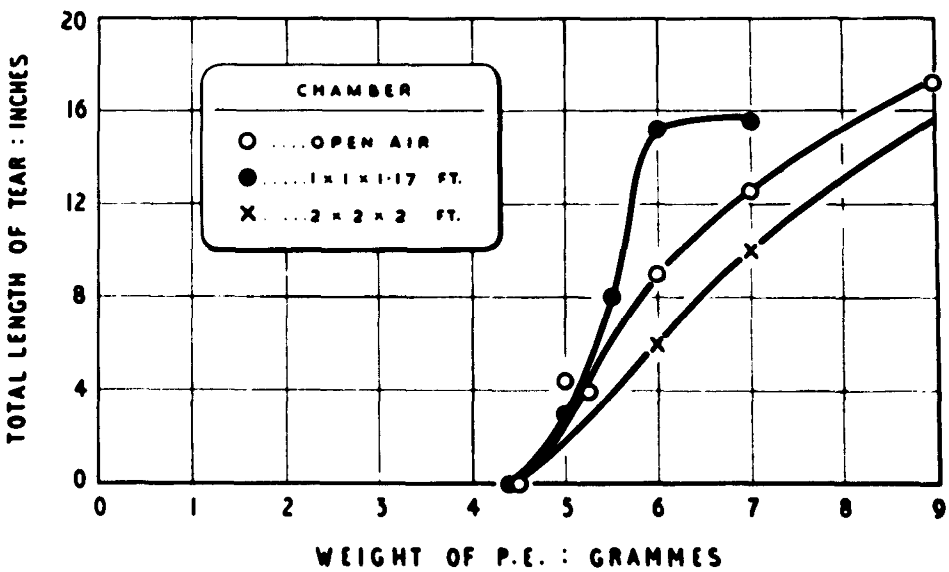
DATA FROM SERIES E AND F : CHAMBER 2X2X2 FT.

FIG. 4



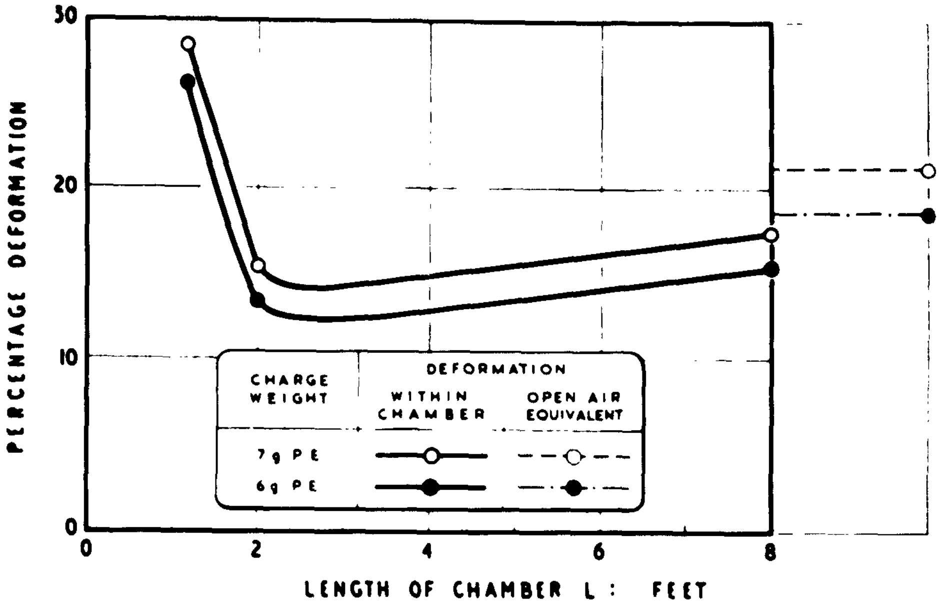
DATA FROM SERIES G,H,I AND K, CHAMBER 3½ × 3½ × 7 FT.

FIG. 5



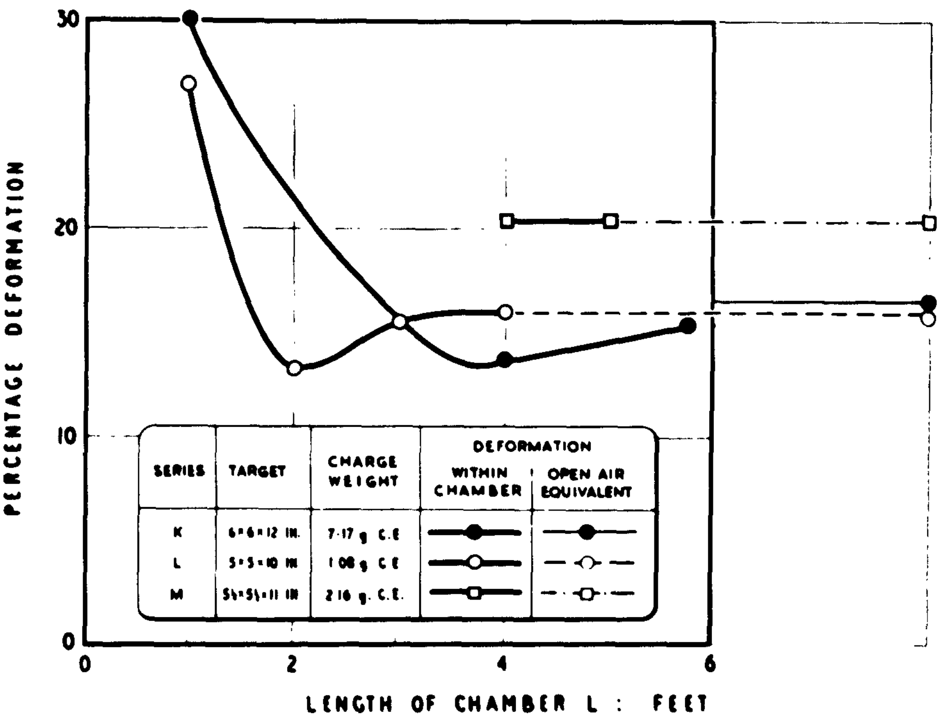
DATA FROM SERIES A AND C, TARGET 6 IN. DIAM. × 12 IN. LONG

FIG 6



DATA FROM SERIES B : TARGET 12×6×6 IN. CHAMBER 1×1×L FT.

FIG 7



DATA FROM SERIES K, L AND M : CHAMBER 2×2×L FT.

FIG 8

For Indexing

SECRET

534.222.2:
541.126

A.R.E. Report 19/53
Sept.1953

Assessment of blast damage to simple structures
Part 1 - Estimation of the chamber effect
J.W.Gibson and T.L.Wall

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

9 pp. 3 figs. 1 phot. Appendix

SECRET

SECRET

534.222.2:
541.126

A.R.E. Report 19/53
Sept.1953

Assessment of blast damage to simple structures
Part 1 - Estimation of the chamber effect
J.W.Gibson and T.L.Wall

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

9 pp. 3 figs. 1 phot. Appendix

SECRET

SECRET

534.222.2:
541.126

A.R.E. Report 19/53
Sept. 1953

Assessment of blast damage to simple structures
Part 1 - Estimation of the chamber effect
J.W. Gibson and T.L. Wall

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

9 pp. 3 figs. 1 phot. Appendix

SECRET

SECRET

534.222.2
541.126

A.R.E. Report 19/53
Sept. 1953

Assessment of blast damage to simple structures
Part 1 - Estimation of the chamber effect
J.W. Gibson and T.L. Wall

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

9 pp. 3 figs. 1 phot. Appendix

SECRET

SECRET

534.222.2
541.126

A.R.E. Report 19/53
Sept. 1953

Assessment of blast damage to simple structures
Part 1 - Estimation of the chamber effect
J.W. Gibson and T.L. Wall

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

9 pp. 3 figs. 1 phot. Appendix

SECRET

SECRET

534.222.2
541.126

A.R.E. Report 19/53
Sept. 1953

Assessment of blast damage to simple structures
Part 1 - Estimation of the chamber effect
J.W. Gibson and T.L. Wall

Small charges of H.E. have been exploded centrally in open-ended rectangular steel boxes having dimensions in the ratio 1 x 1 x 2, and the amount of deformation is taken as a measure of damage. The amount is influenced by the dimensions of the confining chamber within which the target box is suspended prior to detonation. It has been found that the damage is within 1 per cent. of the damage resulting from a trial in the open if the linear dimensions of the chamber exceed 4-1/2 times the linear dimensions of the target. More specifically the cross-section of the confining chamber must exceed a certain minimum and there is a critical length for each cross-section which exceeds this minimum.

Comparisons have been made with open-ended cylindrical rivetted cans and further trials with other target structures are to be made.

9 pp. 3 figs. 1 phot. Appendix SECRET

dstl

Information Centre
Knowledge Services
[dstl] Porton Down,
Salisbury
Wilts
SP4 0JQ
22060-6218
Tel: 01980-613753
Fax 01980-613970

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suit 0944
Fort Belvoir, VA 22060-6218
U.S.A.

AD#: AD020398

Date of Search: 30 July 2008

Record Summary: DEFE 15/2124

Title: Assessment of blast damage to simple structures: part 1, estimation of the chamber effect
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) ARE Report 19/53
Held by The National Archives, Kew

This document is now available at the National Archives, Kew, Surrey, United Kingdom.

DTIC has checked the National Archives Catalogue website (http://www.nationalarchives.gov.uk) and found the document is available and releasable to the public.

Access to UK public records is governed by statute, namely the Public Records Act, 1958, and the Public Records Act, 1967.
The document has been released under the 30 year rule.
(The vast majority of records selected for permanent preservation are made available to the public when they are 30 years old. This is commonly referred to as the 30 year rule and was established by the Public Records Act of 1967).

This document may be treated as UNLIMITED.